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㉓ Catalysts for the polymerization of olefins.

㉔ Catalysts for the polymerization of olefins, particularly alpha olefin  $\text{CH}_2 = \text{CHR}$  in which R is an alkyl radical with 1-6 carbon atoms or an aryl radical, obtained by the reaction of:

a) an Al-alkyl compound;

b) an ether containing at least two ether groups which can form complexes with anhydrous magnesium dichloride, under standard conditions of reaction, in amount less than 60 mmol per 100 g Mg dichloride; and

c) a solid catalyst component comprising an anhydrous magnesium dihalide in active form and having supported thereon a titanium compound containing at least a Ti-halogen bond and an electron-donor compound which is extractable with Al-triethyl, under standard conditions of extraction, for at least 70% in mol, wherein the solid, after extraction, has a surface area of more than 20  $\text{m}^2/\text{gr}$ .

EP 0 362 705 A2

## CATALYSTS FOR THE POLYMERIZATION OF OLEFINS

This invention relates to catalysts for the polymerization of olefins and their use particularly in the polymerization of olefins  $\text{CH}_2 = \text{CHR}$  in which R is an alkyl radical with 1-6 C or an aryl radical.

Catalysts containing titanium compounds supported on magnesium halides in active form are well known in the art.

5 Catalysts of this type were described for the first time in Belgian patent 742,112 and corresponding to U.S. patent No. 4,278,718.

The catalysts referred to in the above Belgian patent, even though endowed with high activity either in ethylene or alpha-olefin such as, propylene polymerization, show a very low stereospecificity.

10 Improvements in stereospecificity were obtained by adding an electron donor compound to the supported component containing the titanium compound, see e.g. U.S. patent No. 4,544,713.

Further improvements were obtained by using both an electron donor in the solid catalyst component and an electron donor with the Al-alkyl compound co-catalyst, see e.g. U.S. patent No. 4,107,414.

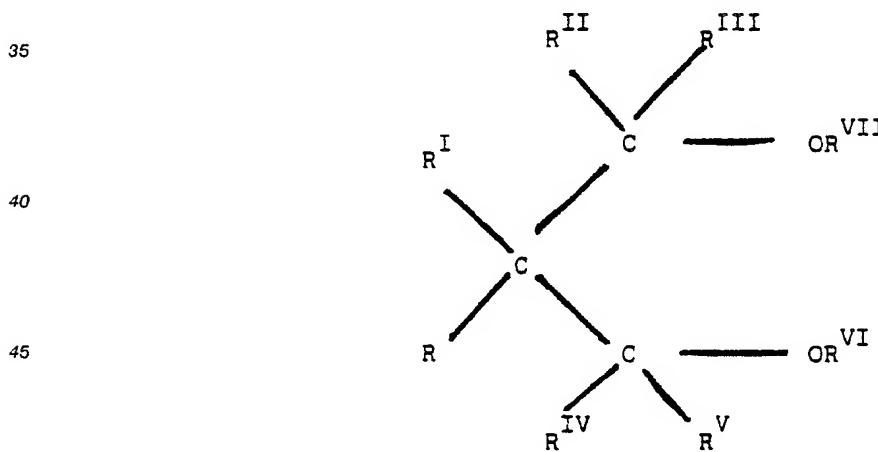
15 High performances both in activity and stereospecificity, were obtained by the catalysts described in European patent No. 0045977. These catalysts comprise a solid catalyst component containing magnesium dihalide in active form on which is supported a titanium halide ( $\text{TiCl}_4$ ) and an electron-donor compound selected from specific classes of carboxylic acid esters, of which the phthalates are typical preferred relevant examples. As co-catalysts, a system formed of an Al-alkyl compound and a silicon compound having at least one  $\text{Si-OR}$  bond, where R is a hydrocarbon radical, is used.

20 In U.S. patent No. 4,522,930 are described catalysts having a solid catalyst component containing an electron donor that is extractable with Al-triethyl under standard conditions of extraction, for at least 70% by mol from the solid, and the surface area of the solid component is at least  $20 \text{ m}^2/\text{g}$ , after extraction. These catalysts include in addition to the solid component and the Al-triethyl compound, an electron donor which does not undergo complex formation with Al-triethyl detectable by potentiometric titration. The electron donors mentioned comprise silicon compounds with  $\text{Si-OR}$  bonds, 2,2,6,6-tetramethylpiperidine, 2,2,5,5-tetramethylpyrrolidine, Al-diethyl-2,2,6,6-tetramethylpiperidine and Al-dichloromonophenoxy.

25 A new class of electron donors different in their structure from the electron donors used up to now has now been found, which form catalysts endowed with high activity and stereospecificity.

30 The electron donors used in the catalysts of the invention are selected from ethers containing two or more ether groups and capable of complexing anhydrous magnesium dichloride having a specific degree of activation for less than 60 mmoles per 100 g of  $\text{MgCl}_2$ .

Ethers having the above mentioned characteristics are 1,3-diethers of the formula:



50 in which R,  $\text{R}^1$ ,  $\text{R}^{\text{II}}$ ,  $\text{R}^{\text{III}}$ ,  $\text{R}^{\text{IV}}$  and  $\text{R}^{\text{V}}$  are the same or different and are H, linear or branched alkyl radicals, or cycloalkyl, aryl, alkylaryl or arylalkyl radicals with 1-18 carbon atoms, provided R and  $\text{R}'$  and not both are hydrogen;  $\text{R}^{\text{VI}}$  and  $\text{R}^{\text{VII}}$  have the same meaning of R and  $\text{R}'$  except for hydrogen; provided that when  $\text{R}^1$  to  $\text{R}^{\text{V}}$  are hydrogen and  $\text{R}^{\text{VI}}$  and  $\text{R}^{\text{VII}}$  are methyl, R is not methyl; and one or more R to  $\text{R}^{\text{VII}}$  can be linked to

form a cyclic structure.

When the radicals from R<sup>I</sup> to R<sup>V</sup> are hydrogen and R<sup>VI</sup> and R<sup>VII</sup> are methyl, R is other than methyl.

Relevant examples of the above mentioned ethers are:

5 2-(2-ethylhexyl)-1,3-dimethoxypropane, 2-isopropyl-1,3-dimethoxypropane, 2-methyl-1,3-dimethoxypropane, 2-butyl-1,3-dimethoxypropane, 2-sec-butyl-1,3-dimethoxypropane, 2-cyclohexyl-1,3-dimethoxypropane, 2-phenyl-1,3-dimethoxypropane, 2-tert-butyl-1,3-dimethoxypropane, 2-cumyl-1,3-diethoxypropane, 2-(2-phenyl-ethyl)-1,3-dimethoxypropane, 2-(2-cyclohexylethyl)-1,3-dimethoxypropane, 2-(2-p-chlorophenyl)-1,3-dimethoxypropane, 2-(diphenylmethyl)-1,3-dimethoxypropane, 2-(1-naphthyl)-1,3-dimethoxypropane, 2-(p-fluoro phenyl)-1,3-dimethoxypropane, 2-(1-decahydronaphthyl)-1,3-dimethoxypropane, 2-(p-tert-butylphenyl)-1,3-dimethoxypropane, 2,2-dicyclohexyl-1,3-dimethoxypropane, 2,2-diethyl-1,3-dimethoxypropane, 2,2-dipropyl-1,3-dimethoxypropane, 2,2-dibutyl-1,3-dimethoxypropane, 2,2-diethyl-1,3-diethoxypropane, 2,2-dipropyl-1,3-diethoxypropane, 2,2-dibutyl-1,3-diethoxypropane, 2-methyl-2-ethyl-1,3-dimethoxypropane, 2-methyl-2-propyl-1,3-dimethoxypropane, 2-methyl-2-benzyl-1,3-dimethoxypropane, 2-methyl-2-phenyl-1,3-dimethoxypropane, 2-methyl-2-cyclohexyl-1,3-dimethoxypropane, 2-methyl-2-methylcyclohexyl-1,3-dimethoxypropane, 2,2-bis(p-chlorophenyl)-1,3-dimethoxypropane, 2,2-bis-(2-phenylethyl)-1,3-dimethoxypropane, 2,2-bis(2-cyclohexylethyl)-1,3-dimethoxypropane, 2-methyl-2-isobutyl-1,3-dimethoxypropane, 2-methyl-2-(2-ethylhexyl)-1,3-dimethoxypropane, 2,2-di-(2-ethylhexyl)-1,3-dimethoxypropane, 2,2-bis-(p-methylphenyl)-1,3-dimethoxypropane, 2-methyl-2-isopropyl-1,3-dimethoxypropane, 2,2-diisobutyl-1,3-dimethoxypropane, 2,2-diphenyl-1,3-dimethoxypropane, 2,2-dibenzyl-1,3-dimethoxypropane, 2,2-bis-(methylcyclohexyl)-1,3-dimethoxypropane, 2,2-diisobutyl-1,3-diethoxypropane, 2,2-diisobutyl-1,3-dibutoxypropane, 2-isobutyl-2-isopropyl-1,3-dimethoxypropane, 2,2-di-sec-butyl-1,3-dimethoxypropane, 2,2-di-terbutyl-1,3-dimethoxypropane, 2,2-di-neopentyl-1,3-dimethoxypropane, 2-isopropyl-2-isopentyl-1,3-dimethoxypropane, 2-phenyl-2-benzyl-1,3-dimethoxypropane, 2-cyclohexyl-2cyclohexylmethyl-1,3-dimethoxypropane, 1-isopropyl-2,2-dimethyl-1,3-dimethoxypropane, 1,1,3-trimethyl-1,3-dimethoxypropane, 2-isopropyl-2-3,7-dimethyloctyl-1,3-dimethoxypropane, 2,2-diisopropyl-1,3-dimethoxypropane, 2-isopropyl-2-cyclohexylmethyl-1,3-dimethoxypropane, 2,2-diisopentyl-1,3-dimethoxypropane, 2,2-dipropyl-1,3-dimethoxypropane, 2-isopropyl-2-cyclohexyl-1,3-dimethoxypropane, 2,2-dicyclopentyl-1,3-dimethoxypropane, 2-heptyl-2-pentyl-1,3-dimethoxypropane, 2-butyl-2-ethyl-1,3-dimethoxypropane, 2-tert-butyl-2-isopentyl-1,3-dimethoxypropane, 2-(1,5-dimethylhexyl)-2-(3,7-dimethyloctyl)-1,3-dimethoxypropane, 1,7-diisopropyl-30 1,1,7,7-tetramethoxyheptane, 1,1-dimethoxymethyl-cyclohexane.

Other examples of suitable ethers are:

2,3-diphenyl-1,4-diethoxybutane, 2,3-dicyclohexyl-1,4-diethoxybutane, 2,3-dibenzyl-1,4-diethoxybutane, 2,3-dibenzyl-1,4-dimethoxybutane, 2,3-dicyclohexyl-1,4-dimethoxybutane, 2,3-diisopropyl-1,4-dimethoxybutane, 2,3-diisopropyl-1,4-diethoxybutane, 2,2-bis-(p-methylphenyl)-1,4-dimethoxybutane, 2,3-bis-(p-chlorophenyl)-1,4-dimethoxybutane, 2,3-bis-(p-fluorophenyl)-1,4-dimethoxybutane, 2,3-bis-(p-fluorophenyl)-1,4-diethoxybutane, 2,4-diphenyl-1,5-dimethoxypentane, 2,5-diphenyl-1,5-dimethoxypentane, 2,5-diphenyl-1,5-dimethoxypentane, 2,4-diisopropyl-1,5-dimethoxypentane, 2,5-diisopropyl-1,5-dimethoxypentane, 2,5-diphenyl-1,5-dimethoxypentane, 2,4-diisopropyl-1,5-dimethoxypentane, 2,5-diphenyl-1,5-dimethoxypentane, 3-methoxymethyltetrahydrofuran, 3-methoxymethylidioxane, 1,1-dimethoxymethyl-1,2,3,4-tetrahydronaphthalene, 1,1-dimethoxymethyl-decahydronaphthalene, 1,1-dimethoxymethylindane, 2,2-dimethoxymethylindane, 1,1-dimethoxymethyl-2-isopropyl-5-methylcyclohexane, 1,3-diisobutoxypropane, 1,2-diisobutoxyethane, 1,3-diisoamylxypropane, 1,2-diisoamylxyethane, 1,3-dineopentoxypropane, 1,2-dineopentoxyethane, 2,2-tetramethylene-1,3-dimethoxypropane, 2,2-pentamethylene-1,3-dimethoxypropane, 2,2-hexamethylene-1,3-dimethoxypropane, 1,2-bis(methoxymethyl)cyclohexane, 2,8-dioxaspiro-(5,5)-undecane, 3,7-dioxabicyclo-(3,3,1)-nonane, 3,7-dioxabicyclo-(3,3,0)octane, 3,3-diisobutyl-1,5-dioxanane, 6,6-diisobutylidioxepane, 1,1-dimethoxymethylcyclopropane, 1,1-bis(methoxymethyl)cyclohexane, 1,1-bis(methoxymethyl)bicyclo(2,2,1)heptane, 1,1-dimethoxymethylcyclopentane, 2-methyl-2-methoxymethyl-1,3-dimethoxypropane, orthomethoxybenzylmethylether, 1,1,1-trimethoxymethylethane, tetramethoxymethylmethane, 1,2-bis(methoxymethyl)bicyclo(2,2,1)heptane, 1,1,2,2-tetramethyl-1,2-dimethoxyethane, 1,2-dimethyl-1,2-dimethoxyethane, 2,2,3,2-tetramethyl-1,4-dimethoxybutane, 2,2,3,3-tetraethyl-1,4-dimethoxybutane, 2,2,3,3-tetramethyl-1,4-diethoxybutane, 2,2,3,3-tetraethyl-1,4-diethoxybutane.

50 Preferred ethers are those having the general formula herein above and particularly those in which R<sup>VI</sup> and R<sup>VII</sup> are methyl and R and R<sup>I</sup> are the same or different and are isopropyl, isobutyl, t-butyl, cyclohexyl, isopentyl, ethylcyclohexyl, pentyl, cyclopentyl, heptyl, 1,5-dimethylhexyl, 3,7-dimethyloctyl, phenyl, cyclohexylmethyl and propyl. Particularly preferred are 2,2-diisobutyl-1,3-dimethoxypropane, 2-isopropyl-2-isopentyl-1,3-dimethoxypropane, 2,2-bis-(cyclohexylmethyl)-1,3-dimethoxypropane.

55 The above ethers can be prepared according to the methods disclosed in Italian patent application No. 22152 A/88 and in the European patent application , Case HM 3854, of the same Applicant and filed on the same date as the present application with the title "Diethers Usable In The Preparation Of Ziegler-Natta Catalysts" (see Enclosure A).

The test of ether complexation of  $MgCl_2$  is carried out as follows. Into a 100 ml glass flask with a fixed blade glass stirrer under a nitrogen atmosphere 70 ml anhydrous n-heptane, 12 mmols anhydrous  $MgCl_2$ , activated as hereinafter described, and 2 mmols ethers was introduced and heated at 60° for 4 hours with a stirring velocity of 400 rpm. The reaction mixture was filtered and washed at room temperature with 100 ml portions of n-heptane and then dried with a mechanic pump.

5 The solid, after treatment with 100 ml of ethanol, was analyzed by gaschromatography to determine the quantity of ether complexed. The complexation tests results are reported in Table I. The magnesium dichloride used in the complexation test with ether was prepared as follows: in a vibratory mill jar (Siebtechnik Vibratom), having a 1 liter capacity and loaded with 1,8 Kg of steel spheres with 16 mm 10 diameter, was introduced under nitrogen atmosphere 50 g anhydrous  $MgCl_2$  and 6,8 ml 1,2-dichloroethane (DCE).

It was milled for 96 hours at room temperature after which the solid was recovered and kept under vacuum at 50° for 16 hours.

15 Solid characterization:

- Half peak breadth of reflection D110 = 1.15 cm.
- Surface area (BET) = 125 m<sup>2</sup>/g.
- DCE residual = 2.5% by weight.

20 Catalyst components usable with the electron donors of this invention are described in U.S. patent No. 4,522,930 the description of which is incorporated herein by reference. As already mentioned, the solid catalyst components described in the U.S. patent No. 4,522,930 comprise a titanium component with at least a Ti-halogen bond and an electron donor-compound which is extractable with Al-triethyl under standard conditions of extraction for at least 70% by mol from the solid. After extraction, the solid has a surface area (B.E.T.) of at least 20 m<sup>2</sup>/g and in general comprised between 100 and 300 m<sup>2</sup>/g.

25 The electron-donor compounds suitable to prepare the catalyst components described in the U.S. patent include ethers, ketones, lactones, electron donors compounds with N, P and/or S atoms and specific classes of esters. In addition to the esters of U.S. patent No. 4,522,930, the esters described in the European patent 45,977 are also suitable.

30 Particularly suitable are the esters of phthalic acid, such as diisobutyl, dioctyl, diphenyl and benzyl-butyphthalate; esters of malonic acid, such as diisobutyl and diethylmalonate; alkyls and arylpivalates; alkyl, cycloalkyl and arylmaleates; alkyl and aryl carbonates such as diisobutyl, ethyl-phenyl and diphenylcarbonate; succinic acid esters mono and diethyl succinate. The esters of phthalic acid are the preferred donors.

35 The preparation of the solid catalyst components is carried out according to several methods. In one method, the magnesium dihalide in an anhydrous state containing less than 1% water, the titanium compound and the electron-donor compound are milled together under conditions in which activation of the magnesium dihalide occurs. The milled product is then treated one or more times with an excess of  $TiCl_4$  at a temperature between 80 and 135°C, and then washed repeatedly with a hydrocarbon solvent such as hexane, until there are no chlorine ions in the water.

40 According to another method anhydrous magnesium dichloride is preactivated according to well known methods and then treated with an excess  $TiCl_4$  containing in solution an electron donor compound at a temperature of about 80° to 135°C. The treatment with  $TiCl_4$  is repeated and the solid is washed with hexane to eliminate any non-reacted  $TiCl_4$ .

45 According to another method an adduct  $MgCl_2 \cdot nROH$  (especially in the form of spherical particles) in which n is 1 to 3 and ROH is ethanol, butanol, isobutanol, is treated with an excess  $TiCl_4$  containing an electron-donor compound in solution at a temperature of about 80 and 120°C. After reaction, the solid is again treated with  $TiCl_4$ , then separated and washed with hydrocarbon until the chlorine ions are removed.

50 According to a further method, magnesium alcoholates or chloroalcoholates (in particular chloroalcoholates prepared according to U.S. patent No. 4,220,554) are reacted with an excess of  $TiCl_4$  containing in solution an electron-donor compound, operating also under the reaction conditions described above.

According to another method, complexes of magnesium halides with titanium alcoholates (complex  $MgCl_2 \cdot 2Ti(OC_4H_9)_4$  is an example) are reacted in hydrocarbon solution with an excess of  $TiCl_4$  containing in solution an electron-donor compound; the solid product is separated and then further reacted with an excess of  $TiCl_4$  at 80°-120°C. The solids were then separated and washed with hexane.

55 According to a variant of the above method, the complex between  $MgCl_2$  and the titanium alcoholate is reacted in an hydrocarbon solution with hydropolyxylosane. The solid product is separated and reacted at 50°C with silicon tetrachloride containing in solution an electron-donor compound. The solid is then reacted with excess  $TiCl_4$  at 80°-100°C.

In addition to the above methods it is possible to react an excess of  $TiCl_4$  containing in solution an

electron-donor compound with porous styrene-divinylbenzene resins in the form of spherical particles or inorganic porous supports, such as silica and alumina impregnated with a solution of Mg compound or complexes soluble in organic solvents.

The porous resins which can be used in the present invention and their impregnation method are 5 described in U.S. patent application Serial No. 07/359,234.

Reaction with  $TiCl_4$  is carried out at 80-100°C; after separating the  $TiCl_4$  excess, the reaction is repeated and the solid is then washed with hydrocarbon.

The molar ration between  $MgCl_2$  and the electron-donor compound used in the above described reactions is between 4:1 and 12:1. The amount of electron-donor compound which remains fixed on the 10 magnesium dihalide is between 5 and 20 mole %. In the case of components supported on resins and inorganic porous supports, the molar ratio between the electron-donor compound and magnesium is higher and in general comprised between 0.3 and 0.8.

In the solid catalyst components the ratio Mg/Ti is usually between 30:1 and 4:1. When the components are supported on a resin or on an inorganic porous support the ratio is lower and is generally between 3:1 and 15 2:1.

Suitable titanium compounds used for the preparation of the solid catalyst components are the halides and the haloalcoholates. Titanium tetrachloride is the preferred compound. Satisfactory results are also obtained with Ti-trihalides in particular  $TiCl_3$ -HR,  $TiCl_3$ -ARA, and with haloalcoholates like  $TiCl_3$  OR in which R is a phenyl radical.

20 The above mentioned reactions lead to the formation of magnesium halides in active form. Besides these reactions, other reactions are well known in literature which form magnesium halides in active form starting from magnesium compounds different from the halides.

The active form of magnesium dihalides in the solid catalyst components, is evidenced in X-rays spectrum of the catalyst component in which the most intense reflection line appearing in the spectrum of a 25 non-activated magnesium dihalide having a surface area less than  $3 m^2/gr$ , is absent and substituted by a halo with the maximum of intensity shifted with respect to the position of the most intense reflection line, or from the fact that the most intense reflection line shows a half peak breadth of at least 30% greater than the breadth of the most intense reflection line appearing in the spectrum of non-activated Mg dihalide. The 30 most active forms are those in which the halo appears in the X-rays spectrum of the solid catalyst component.

The highly preferred magnesium halides is magnesium dichloride. In the case of the most active forms of magnesium dichloride, the X-ray spectrum of the catalyst component shows a halo in place of the most intense diffraction line that in the spectrum of non-activated magnesium dichloride which appears at a distance of 2.56 Å.

35 The solid catalyst component of the present invention forms, by reaction with Al-alkyl compounds, catalysts suitable for the polymerization of olefin  $CH_2 = CHR$  in which R is hydrogen, an alkyl radical with 1-6 carbon atoms, an aryl radical, or mixtures of said olefins with each other and/or with dicolefins such as butadiene.

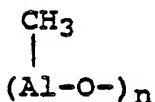
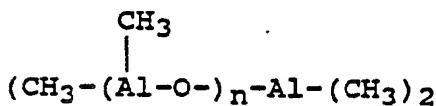
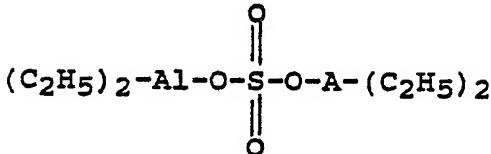
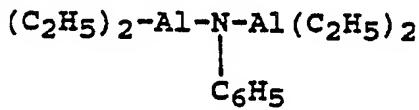
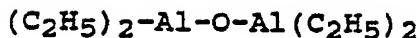
In case of the polymerization of  $CH_2 = CHR$  olefins in which R is an alkyl radical with 1-6 carbon atoms 40 or an aryl radical, particularly when the olefin is propylene, the Al-alkyl compounds are selected from the Al-trialkyls such as Al-triethyl, Al-triisobutyl, Al-tri-n-butyl and linear or cyclic Al-alkyl compounds containing two or more atoms of Al linked each other through an oxygen or a nitrogen atom or through  $SO_4$  and  $SO_3$  groups.

Examples of these compounds are:

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25 in which n is a number from 1 to 20.  
 In addition  $AlR_2OR'$  compounds, in which  $R'$  is an aryl radical substituted in one or both of ortho positions and R is an alkyl radical with 1-6 carbon atoms, and  $AlR_2H$  compounds in which R has the meaning as above indicated are also suitable. The Al-alkyl compound is an amount such that the ratio of Al/Ti is between 1 and 1000.

30 In the case of propylene polymerization and other alpha olefins, the trialkyl compounds may be used in mixture with Al-alkyl halides such as  $AlEt_2Cl$ .

The catalysts of the invention include the product of the reaction between the following components:

- a) An Al-alkyl compound, in particular an Al-trialkyl compound;
- b) An ether with at least two ether groups, which complexes with anhydrous magnesium dichloride in active form under standard conditions, less than 60 mmols/100 g  $MgCl_2$  chloride;
- 35 c) a solid comprising an anhydrous magnesium halide in active form having supported thereon a titanium compound with at least one Ti-halogen bond and an electron-donor compound which is extractable for more than 70 mol % from the solid compound by reaction with Al-triethyl under standard conditions of extraction, the solid component after extraction having a surface area of more than 20 m<sup>2</sup>/g.

40 Olefin polymerization is carried out according to known methods in liquid phase using the liquid monomer or a solution of liquid monomer or monomers in an aliphatic or aromatic hydrocarbon solvent, in gas phase or in a combination of liquid phase and gas phase processes.

The temperature of (co)polymerization is generally from 0° to 150°C; in particular between 60° and 100°C. The polymerizations are carried out at atmospheric or higher pressure.

45 The catalysts can be precontacted with small quantities of olefin monomer (prepolymerization). Prepolymerization improves the catalysts performance as well as polymer morphology.

Prepolymerization is carried out by maintaining the catalyst in suspension in a hydrocarbon solvent (hexane, heptane, etc) at a temperature range from room temperature to 60°C for a time sufficient to produce a quantity of polymer from 0.5 to 3 times the weight of the solid catalyst component. Prepolymerization can also be carried out in liquid propylene under the same conditions of temperature as above to produce up to 1000 g polymer per g of catalyst component.

In the case of stereoregular polymerization of olefins, the molar ratio between the Al-alkyl compound and the ether donor is in general from 5:1 to 100:1.

The following examples are illustrative but not limiting the invention.

Preparation of the solid catalyst component.

5      Into a 500 ml reactor equipped with a filter disk on the bottom was introduced 225 ml  $TiCl_4$  at 0°C and with stirring over a period of 15 minutes, 10.1 g (54 mmols)  $MgCl_2 \cdot 2C_2H_5OH$  in microspherical form prepared according to example 1 of U.S. patent No. 4,469,648 was added.

10     Upon completion of the addition, the temperature was raised to 40°C and 9 mmols diisobutylphthalate was introduced. The temperature was then raised to 100°C over 1 hour and the mixture was reacted for 2 hours. The excess  $TiCl_4$  was then removed by filtration. 200 ml  $TiCl_4$  was then added and the contents heated at 120°C for 1 hour with stirring. The mixture was filtered and the solid washed with n-heptane at 60° until no chlorine ions were in the filtrate.

Polymerization.

15     In a 2000 ml stainless steel autoclave equipped with an anchor stirrer there was introduced at 25°C under propylene flow 1000 ml n-heptane, 5 mmols  $Al(C_2H_5)_3$ , 30 mg of catalyst component and 1 mmol of an ether compound set forth in Table 2.

20     The autoclave was closed. After having set the pressure at 1 atm, 0.2 atm hydrogen was introduced and the contents heated at 70°C while feeding propylene up to the total pressure of 7 atm.

25     The polymerization was carried out for 2 hours. During that period monomer feeding was continued. The polymer was isolated by filtration at the end of the reaction period, and vacuum dried. The remaining portion of polymer in the filtrate was precipitated with methanol, vacuum dried and considered in determining the total residue extractable with n-heptane.

30     The ethers donor used, the results of the polymerization (yield and total isotactic index II) and the intrinsic viscosity of polymer produced are reported in Table 2.

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TABLE 1

## 5      ETHERS

COMPLEXATION  
10      WITH MgCl<sub>2</sub> (\*)

15	2,2 - dimethyl	
	1,3 - dimethoxypropane	3.5
20	2 methyl-2isopropyl	
	1,3-dimethoxypropane	1.6
25	2,2-diisobutyl	
	1,3-dimethoxypropane	3.3
30	2,2-diisobutyl	
	1,3-diethoxypropane	2.0
35	2,2-diisobutyl	
	1,3-di-n-butoxypropane	0.5
40	2,2-diphenyl	
	1,3-dimethoxypropane	0.7
45	2,2-bis (methylcyclohexyl)	
	1,3-dimethoxypropane	1.8
50	1,3-diisobutoxypropane	2.6

5	2,2-pentamethylen	
	1,3-dimethoxypropane	2.4
10	1,1-bis (methoxymethyl) bicyclo (2,2,1) heptane)	1.9
15	1-isopropyl-2,2-dimethyl 1,3-dimethoxypropane	1.3
20	2-isopentyl-2-isopropyl 1,3-dimethoxypropane	2.7
25	1,3-dimethoxypropane	9.6
30	1,2- dimethoxyethane	9.4

(\*) Mols  $\times 10^2$  of ether complexed per 100 g  $MgCl_2$ .

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TABLE 2

5	Ex.	Ether	Yield g PP/g cat. comp.	I.I. %	Intrinsic viscosity dl/g
10	1	2,2-dimethyl- 1,3-dimethoxypropane	1600	85.1	
15	2	2-methyl-2-isopropyl 1,3-dimethoxypropane	2300	96.7	1.95
20	3	2,2-diisobutyl- 1,3-dimethoxypropane	8500	97.4	1.53
25	4	2,2-diisobutyl- 1,3-diethoxypropane	3100	92.8	
30	5	2,2-diisobutyl- 1,3-di-n-butoxypropane	2400	87.7	1.45
35	6	2,2-diphenyl- 1,3-dimethoxypropane	5700	98.7	
40	7	2,2-bis (methylcyclohexyl) 1,3-dimethoxypropane	5000	92.7	1.30

TABLE 2

5	8	1,3-diisobutoxypropane	2900	73.2	
10	9	2,2-pentamethylene	2500		
		1,3-dimethoxypropane		92.0	
15	10	1,1-bis (methoxymethyl)			
		bicyclo-(2,2,1)-heptane	2900	89.1	
20	11	2-isopentyl-2-isopropyl-			
		1,3-dimethoxypropane	3950	98.5	
25	12	1-isopropyl-2,2-dimethyl-			
		1,3-dimethoxypropane	2500	88.8	1.33
30	13	2,2,3,3-tetraethyl			
		1,3-dimethoxybutane	4200	90.6	
35	14	1,2-bis (methoxymethyl)			
		bicyclo-(2,2,1)-heptane	3800	97.4	
40	15	1,1,2,2-tetramethyl			
		1,2-dimethoxyethane	2100	90.6	
45	16	o-methylmethoxy anisole	2000	87.0	1.75
50					

TABLE 2

5	17	2,2-dibenzyl 1,3-dimethoxypropane	5100	88	1.20
10	18	2-isopropyl-2-3,7-dimethyl- octyl-1,3-dimethoxypropane	3790	97	
15	19	2,2-diisopropyl-1,3-dimethoxy- propane	4550	99	
20	20	2-isopropyl-2-cyclohexymethyl- 1,3-dimethoxypropane	3900	98.9	
25	21	2,2-dicyclohexyl-1,3-dimethoxy- propane	3890	97.3	
30	22	2-isopropyl-2-isobutyl- 1,3-dimethoxypropane	10500	97.8	1.40
35	23	2,2-diisopentyl-1,3-dimethoxy- propane	3680	96.2	
40	24	2,2-dipropyl-1,3-dimethoxy- propane	4500	95.8	
45	25	2-isopropyl-2-cyclohexyl- 1,3-dimethoxypropane	11100	98.5	1.64
50	26	2-isopropyl-2-cyclopentyl- 1,3-dimethoxypropane	10000	98.2	1.50
	27	2,2-dicyclopentyl-1,3-dime- thoxypropane	8600	98.6	1.58
	28	2-heptyl-2-pentyl-1,3-dime- thoxypropane	4320	93	
	29	2-butyl-2-ethyl-1,3-dimethoxy- propane	3260	97	
	30	2-tert.butyl-2-isopentyl- 1,3-dimethoxypropane	9060	93.7	1.47
	31	2-(1,5-dimethylhexyl)-2- (3,7-dimethyloctyl)-1,3- dimethoxypropane	11680	93.1	1.53
	32	1,7-diisopropyl-1,1,7,7,-te- tramethoxyheptane	6250	94.5	1.40

TABLE 2

5	33	2-phenyl-2-methyl-1,3-dimethoxypropane	9300	96.8	1.40
	34	1,1-dimethoxymethyl-cyclohexane".	2450	92	1.56
10	Comp. Ex. 1	1,3-dimethoxypropane	210	62.8	1.33
15	Comp. Ex. 2	1,2-dimethoxyethane	700	70.2	

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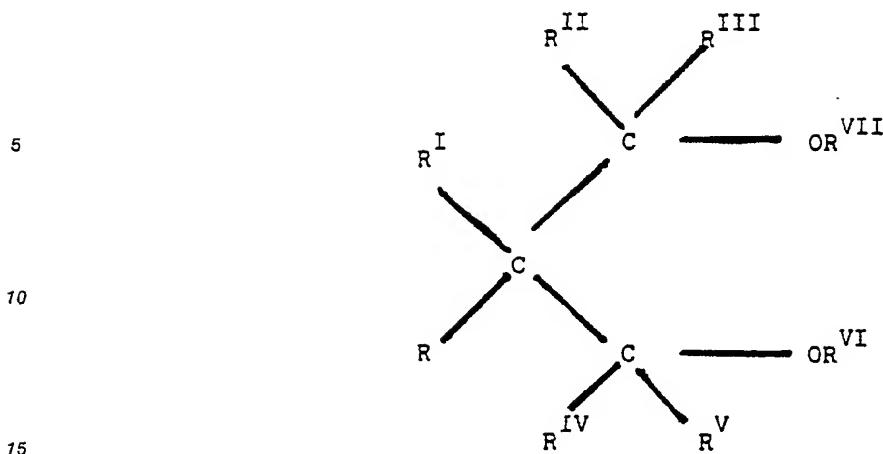
## 25 Claims

1. A catalyst for the polymerization of olefins comprising the reaction product of:
  - a) an Al-alkyl compound;
  - b) an ether with at least 2 ether groups capable of complexing anhydrous magnesium dichloride
- 30 under standard reaction conditions when present in an amount of less than 60 mmols per 100 g magnesium dichloride;
  - c) a solid catalyst component, comprising anhydrous magnesium dihalide in active form and having supported thereon a titanium compound containing at least one Ti-halogen bond and an electron-donor compound which is extractable from the solid with Al-triethyl for more than 70 mol %, wherein the solid after extraction has a surface area of more than 20 m<sup>2</sup>/g.
- 35 2. The catalyst of claim 1 suitable for the polymerization of olefins wherein the olefins have the formula CH<sub>2</sub> = CHR in which R is an alkyl radical with 1-6 carbon atoms or an aryl radical and wherein the Al-alkyl compound is an Al-trialkyl compound or an Al-alkyl compound with one or more Al atoms linked to each other through oxygen, nitrogen atoms or SO<sub>4</sub> or SO<sub>3</sub> groups.
- 40 3. The catalyst of claim 1 wherein the magnesium halide is magnesium dichloride, the titanium compound is a titanium halide and the electron-donor is a phthalic acid ester.
- 45 4. The catalyst of claim 3 in which the phthalic acid ester is selected from diisobutyl and di-n-octylphthalate.
5. The catalyst of one or more of the preceding claims in which the ethers have formula:

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in which R, R<sup>I</sup>, R<sup>II</sup>, R<sup>III</sup>, R<sup>IV</sup> and R<sup>V</sup> are the same or different and are H, linear or branched alkyl radicals, or cycloalkyl, aryl, alkylaryl or arylalkyl radicals with 1-18 carbon atoms, provided R and R' and not both are hydrogen; R<sup>VI</sup> and R<sup>VII</sup> have the same meaning of R and R' except for hydrogen; provided that when R<sup>I</sup> to R<sup>V</sup> are hydrogen and R<sup>VI</sup> and R<sup>VII</sup> are methyl, R is not methyl; and one or more R to R<sup>VII</sup> can be linked to form a cyclic structure.

6. The catalyst of claim 5 in which R<sup>VI</sup> and R<sup>VII</sup> are methyl and R and R<sup>I</sup> are the same or different, and are selected from the group consisting of isopropyl, isobutyl, t-butyl, cyclohexyl, isopentyl, cyclohexylethyl, pentyl, cyclopentyl, heptyl, 1,5-dimethyl-hexyl, 3,7-dimethyloctyl, phenyl, cyclohexylmethyl and propyl.

7. The catalyst of claim 1 in which the ether is

2,2-diisobutyl-1,3-dimethoxypropane,  
 2-isopropyl-2-isopentyl-1,3-dimethoxypropane,  
 2,2-bis-(methylcyclohexyl)-1,3-dimethoxypropane,  
 2-isopropyl-2-3,7-dimethyloctyl-1,3-dimethoxypropane  
 2,2-diisopropyl-1,3-dimethoxypropane,  
 2-isopropyl-2-cyclohexylmethyl-1,3-dimethoxypropane,  
 2,2-dicyclohexyl-1,3-dimethoxypropane,  
 2-isopropyl-2-isobutyl-1,3-dimethoxypropane,  
 2,2-diisopentyl-1,3-dimethoxypropane,  
 2,2-dipropyl-1,3-dimethoxypropane,  
 2-isopropyl-2-cyclohexyl-1,3-dimethoxypropane,  
 2-isopropyl-2-cyclopentyl-1,3-dimethoxypropane,  
 2,2-dicyclopentyl-1,3-dimethoxypropane,  
 2-heptyl-2-pentyl-1,3-dimethoxypropane,  
 2-butyl-2-ethyl-1,3-dimethoxypropane,  
 2-tert.butyl-2-isopentyl-1,3-dimethoxypropane,  
 2-(1,5-dimethylhexyl)-2-(3,7-dimethyloctyl)-1,3-dimethoxypropane,  
 1,7-diisopropyl-1,1,7,7-tetramethoxyheptane,  
 2-phenyl-2-methyl-1,3-dimethoxypropane,  
 1,1-dimethoxymethyl-cyclohexane,  
 2,2-diphenyl-1,3-dimethoxypropane.